CATENARY LIGHTING (A4)
Great West Road

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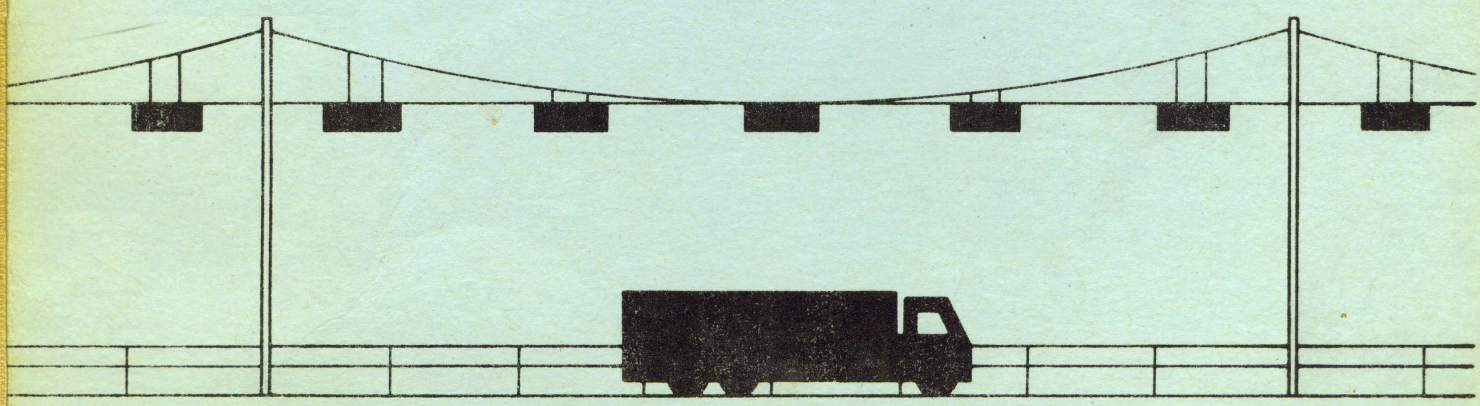

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"CATENARY LIGHTING ON THE GREAT WEST ROAD (A.4), HOUNSLOW"

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1. INTRODUCTION

The catenary system on the A.4 Trunk Road in the London Borough of Hounslow is an entirely new approach to lighting and is the first of its kind in Britain to be installed on an existing trunk road which carries a heavy volume of traffic.

It represents a breakaway in introducing high levels of illumination in place of silhouette vision normally associated with conventional street lighting. At night the axial view of the lamp reduces disability glare to a minimum, whilst the kerbs are well defined and vehicles and pedestrians are "modelled". The motorist does not suffer from constantly changing degrees of brightness but, experiences complete uniformity of illumination. Because the lanterns are suspended axially from longitudinal catenary cables over the central reservation, the road is clearly defined for a considerable distance ahead and this greater visibility is particularly noticeable in wet weather.

Verge columns have been completely eliminated which, in turn, offers several advantages in that it reduces maintenance to a minimum and keeps the cost down by reducing the number of electrical connections.

Catenary lighting is also aesthetically more pleasing by day and night alike in that fewer vertical supports are needed which, in turn, makes for fewer distractions.

2. HISTORY

The A.4 Great West Road in Hounslow is a trunk road and a major radial out of London. It runs, more or less, parallel to the M.4 Motorway and was, until the opening of the M.4, the main arterial road to Bath. The road

2. HISTORY (Cont'd.)

consists of a central reservation of 4 feet in width with dual three-lane (30 feet) carriageways. Between the outer kerb of each carriageway and the back of pavement is a distance of 28 feet made up of two grass verges, a cycle track and a footpath. Thus, the total width of highway is approximately 120 feet. The carriageways are surfaced in hot rolled asphalt, the cycle tracks in concrete, and the footpaths are slab paving.

Prior to the installation of the catenary lighting the road was illuminated by conventional centre and opposite lighting comprising a mixture of concrete and steel columns with 400 watt M.B.F.U. lamps with non-cut off lanterns at a mounting height of 25 feet. This lighting was installed immediately post-war and was partly modified in 1959. It was totally outdated by modern standards and particularly for such a heavily trafficked road carrying something in the order of 42,000 vehicles per day with peak hour flows of 3,800.

In 1968 the Department of the Environment asked the Borough Council, as their Agents, to prepare a new lighting scheme for the Great West Road on a conventional basis of centre reservation and opposite lighting. At that time the Author had had the opportunity of visiting a number of catenary installations in Holland and it was considered that, although the A.4 was an existing dual carriageway road with all its complications, it did, nevertheless, lend itself for catenary lighting.

At that time, the only installation of catenary being installed in the country was at the Worsley braided interchange near Manchester. This, of course, was a new motorway interchange and the lighting formed part of the whole civil engineering works of construction. It was also considered that as there were many miles of existing urban trunk roads in the country of which, no doubt, many would require re-lighting in the not-too-distant future, an experiment should be carried out in order to assess the merits or demerits of such a form of lighting.

The London Highways Division of the Department of the Environment concurred with this suggestion and agreed that a catenary lighting scheme should be installed on an experimental basis.

3. THE SYSTEM

Basically, this is a fixed-wire system comprising 120 centrally mounted columns with 563 lanterns in a 9.5 km. stretch of road which replaced the conventional layout of 300 columns and 444 lanterns.

The column spacing is approximately 70 m. with 5 lanterns per span, except on certain bends when it was necessary to reduce the column spacing to approximately 58 m. with 4 lanterns per span. The lantern mounting height is 10 m. and each lantern houses a 135 watt low-pressure sodium lamp. The general arrangement of the system is shown in Fig. 1.

(a) Columns

As this system was new to this country, the Contractors tendering were asked to submit design details and certificates for the columns at the time of tendering. Broadly, the specification called for column length of 14.3 m. above ground and to effectively support and maintain 5 lanterns per 70 m. span at a mounting height of 10 m. The columns are of steel manufacture and made by Petitjean Co. Ltd. They are octagonal in shape with a continuous taper from base to top. In the case of the intermediate columns, the width at the base is 312 mm. tapering to 150 mm. at the top and overall weight of 600 kg. The end columns have a base width of 494 mm. tapering to 250 mm. at the top and overall weight 1,116 kg. In all cases the thickness of steel is 6 mm.

Each column has a base plate providing for 8 bolts per plate and as the electricity supply is fed into each alternate column, doors were only provided where necessary. Suitable cable outlets were provided at the top of the column together with fixings for the catenary cables and the whole column primed in red oxide.

(b) Lanterns

The specification called for lanterns to be the side-entry, totally enclosed, reflector type for cut-off light distribution and generally in accordance with B.S.1788 and the light distribution is shown on the polar curve diagram (Fig. 2).

The lanterns and lamps were supplied by Philips Electrical Limited, the

(b) Lanterns (Cont'd.)

lanterns having integral control gear.

(c) Lamps

The lamps are of the horizontally burning, low pressure, sodium type, having an average output of 20,000 lumens at 3,000 hours with a maximum rating of 150 watts.

(d) Control

The lighting is controlled by means of photo-electric cells mounted on the canopy of each lantern and each is of the standard lock plug socket type. The units switch on at 70 lux and have a switch-on to switch-off ratio of 1 to 2 and in the event of a fault occurring the mechanism fails safe, (i.e. the lamp switches ON).

As mentioned previously, the electricity supply is fed into each alternate column and the cable was taken from the nearest existing column connection and extended in duct to the foundation of the new catenary column.

(e) Catenary Cables

The cable system was designed to be capable of supporting all the loadings required, together with due allowances for the additional weight and wind surface area which could be imposed by ice and snow coverings.

(i) Upper Catenary Cable

The cable is made up of 7 strands of 7 wires in stainless steel impregnated with black polypropylene with an overall diameter of 6.5 mm. and the tension on a 73 m. span at 10°C is 356.6 kg.

(ii) Lower Catenary Cable

The cable is made up of 7 strands of 7 wires in stainless steel impregnated with black polypropylene with an overall diameter of 5 mm. and the tension on a 73 m. span at 10°C is 288.7 kg.

(iii) Suspension Cable (Lanterns)

This cable is of the same make up as the catenary cables but of 2 mm. diameter and without being impregnated with black polypropylene.

(f) Illumination

The approximate level of illumination that was specified along each carriageway is shown in Fig. 3 and Fig. 4 illustrates the actual levels of illumination achieved taken after the installation was completed and in operation for a period of 2,000 burning hours. It will be seen that the levels achieved are, in the main, higher than specified and with little variance.

4. THE INSTALLATION

The Contractor for the installation was David Webster Limited and in view of the fact that the A.4 is a heavily trafficked road, the Contractor was restricted to working only between the hours of 9.30 a.m. and 4.30 p.m. The police were very insistent that the works should interfere with the flow of traffic as little as possible.

Prior to erection, it was necessary to carry out a very detailed and laborious setting out in order to establish the exact position for the columns. Along the straight lengths, the columns were finally spaced in combinations of 73 and 70 m. depending upon road junctions, but the spacing was reduced to a minimum of 58.4 m. on bends in excess of 5°. This was necessary due to the additional strain on bends, otherwise there would have been a tendency for the columns to have deflected inwards if they had remained at 70 or 73 m. spacing.

As all the work was on the central reservation, advance coning was necessary before any works commenced. After the setting out, the first operation was to excavate the holes for the foundations and concrete bases for the columns. Again, because this was an existing road there were places where up to 2 feet of concrete had to be excavated; this being the foundations to the original old road before it was dualled. The surplus material had to be removed immediately owing to the narrowness of the central reservation. In addition to the old concrete, other obstacles were found and in the case of high tension cables, the Southern Electricity Board agreed to them remaining but protected by fibre split ducts which, in turn, had a ring of reinforcement around them.

The original scheme provided for anchorages to the end columns but it was found that a neater looking job could be achieved by increasing the strength

and size of the end columns over the intermediate ones and providing for larger diameter bolts and larger excavations. Eight bolts per base were used and in the case of the end columns the bolts were 42 mm. diameter by 1,500 mm. length with concrete foundation of 2 m. in depth. For the intermediate columns the bolts were 27 mm. diameter by 700 mm. length with a concrete foundation of 1.5 m. in depth. The spacing of the bolts were 325 mm. centres and 200 mm. centres respectively.

After excavation, the formwork and the anchor bolts were placed in position and a pitch fibre duct was inserted to eventually take the cable. The concrete was provided by means of truck mix lorries which, again, caused the least disruption to traffic.

After pouring, and where necessary, the kerbing to the central reservation was made good. The formwork was left for 24 hours before being moved and the hole was backfilled to await the erection of the column. All foundations were completed before erection took place. The columns themselves were delivered to a nearby depot in two sections, which were drawn together before delivery to the site on a low loader. The columns were erected by means of a mobile crane using double slings and a total of 10 columns per day erected and bolted was achieved. An 150 lb. torque was applied to each bolt and finally the bolts and plates were painted with micaceous iron oxide prior to the final reinstatement of the central reservation.

The next sequence was to raise the catenary cables and lanterns. Firstly, the lanterns were assembled on the ground and attached to the cables. Having assembled the 5 lanterns per span on the ground with their cables attached, the next operation was to hoist the assembly to the top of the column. This was undertaken by means of two hoist frames, one for the upper catenary cable and one for the lower cable. The frames were raised by the use of a multi-gain block and tackle attached to the top of the column. Throughout the lifting, the operation was carried out in under 9 minutes and no road junction was closed for more than 15 minutes. Having hoisted the cables to the top of the columns, the lamp was fitted and the bowl attached to the lantern.

To attach the cables to the column, it was necessary to winch the cable to obtain sufficient slack in order to remove the catenary chain from the upper hoist frame. The chain was then placed in a column fixing tab and, at the other end of the cable, a turnbuckle was fixed to the fixing tab to allow for the final adjustments of the correct tension. Whilst these operations were being carried out to a span, it was necessary to support the column which, at that time, was carrying the weight of the catenary on one side only. This was done by means of a stay wire running from the top of the column in question to the base of the next column.

Finally, the columns were painted with two coats of gloss paint, having been patch primed, where necessary, with zinc chromate.

The existing steel columns in the central reservation had to be removed and at the beginning the Contractor cut the columns approximately 6 feet above the base by means of a petrol driven circular saw; the upper part of the column being removed by an hydraulic arm.

4. THE INSTALLATION (Cont'd.)

This method was changed when it was found that the bracket arms could be twisted and was even further refined by not twisting the arms but, in fact, by swinging the cable over the bracket. Thus it enabled the columns to be removed more or less at leisure and at a much later stage in the operations.

5. THE FUTURE

Although there is much to learn in catenary lighting, both from the design point of view and the erection, it is a form of lighting which has many advantages and little disadvantages. It has a future for dual-carriageways and motorways. Maintenance is more economical as there are fewer columns and all cleaning and bulk changing can be carried out from one carriageway. This is a distinct advantage on the A.4 Trunk Road which suffers from tidal flows, albeit requires a fast lane closure.

As far as painting is concerned there are $\frac{1}{5}$ the number of columns compared to a conventional opposite layout and $\frac{2}{5}$ths in the case of centre double arm columns. However the size of column is greater so the nett saving is in the order of 60% and 30% respectively.

With regard to the bulk changing and cleaning it has been found that on average 10% more lanterns can be dealt with per day.

However, the cost of installation is more expensive than a conventional system. The additional cost in erecting is likely to be reduced in the future as more people have experience in this type of system.

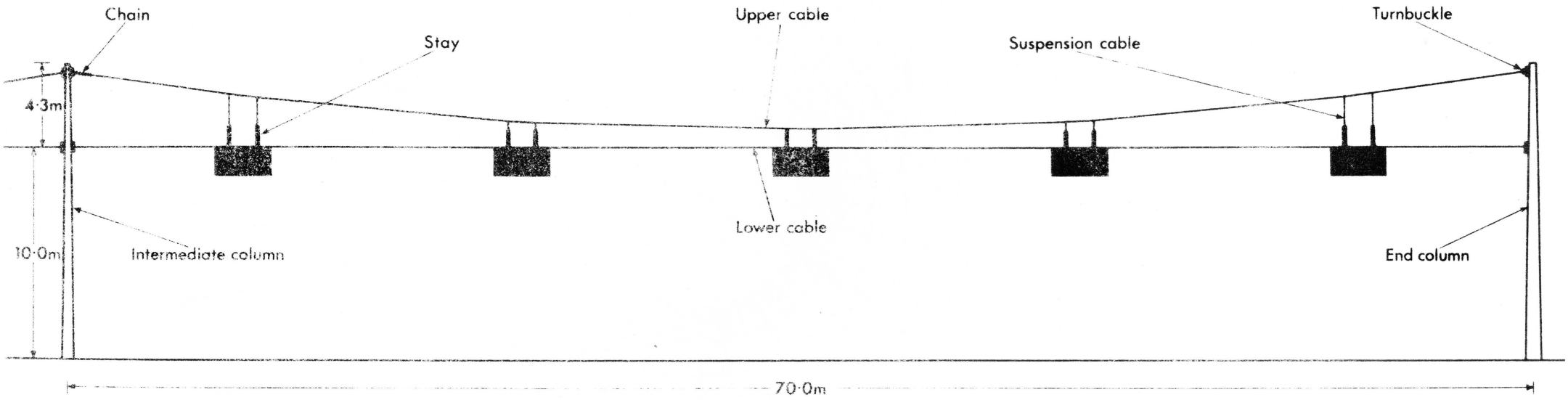
One of the major advantages which has "come to light" since the system has been working is the road safety aspect. During the four winter months (October - January) there has been a significant reduction in road accidents and Figure 5 shows that for the two years prior to the installation the total accidents during the four winter months averaged $36\frac{1}{2}$ whilst the average of the three years since

installation is 18, (i.e. a 50% reduction). A point worthy of mention is the reduction in fatal and serious accidents - only one fatal accident in the three post years as compared with three in the two previous years. In terms of cost of accidents (Accident Division of T.R.R.L. gives fatal £23,000 and serious £1,700) it can be calculated from the figures that the scheme has almost paid for itself. This is very encouraging considering that one is comparing the catenary system with an old standard Group A installation. Such a 50% reduction is usually expected when lighting an unlit road having a speed limit of 70 m.p.h. In the case of roads with a speed limit (as in the case along the A.4) one expects a 33% reduction.

Mention should be made that the Department of the Environment has recently agreed to a further scheme of catenary lighting in conjunction with the dualling of a length of the A.30 Trunk Road (Great South West Road) within the Borough. The scheme is, at present, under design and, in this case, it is proposed to install a running wire system rather than a fixed wire system, thus enabling further experience to be gained in catenary lighting.

Finally, tribute should be paid to the main Contractor for the installation and to the suppliers of the columns, catenary system and lanterns and, in particular, for their enthusiasm and the way they co-operated with the London Borough of Hounslow in order to install and light a new and advanced form of lighting.

An acknowledgment should be paid to the Department of the Environment for sanctioning the scheme and the encouragement given by the London Highways Division and also to the Borough Council who had confidence in the new system and who are always prepared to "light the way ahead" with new projects and systems.



GENERAL ARRANGEMENT OF CATENARY SYSTEM
AS USED ON A4 (SCHEMATIC)

FIG 1

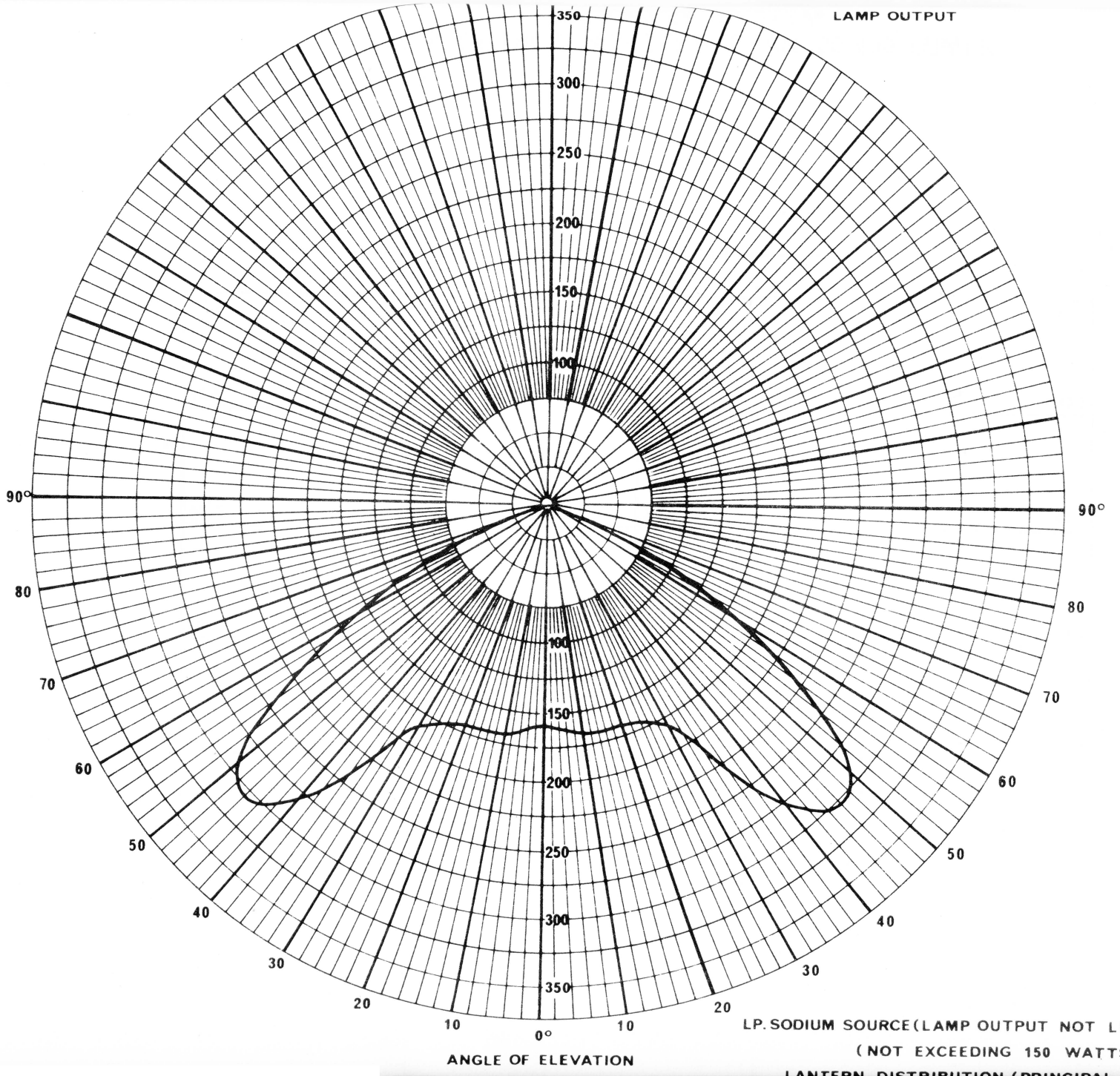


FIG 2

LP. SODIUM SOURCE (LAMP OUTPUT NOT LESS THAN 20,000 LUMENS)
(NOT EXCEEDING 150 WATTS)
LANTERN DISTRIBUTION (PRINCIPAL POLAR CURVE)

CATENARY SYSTEM
LAMP OUTPUT NOT LESS THAN 20,000 LUMENS

FIGURES SHOW LUX VALUES
AT POINTS ON THE CARRIAGEWAY
(3 x 10ft traffic lanes) (Maximum tolerance ±5%)
(Approx 3 x 3·0480m. traffic lanes)

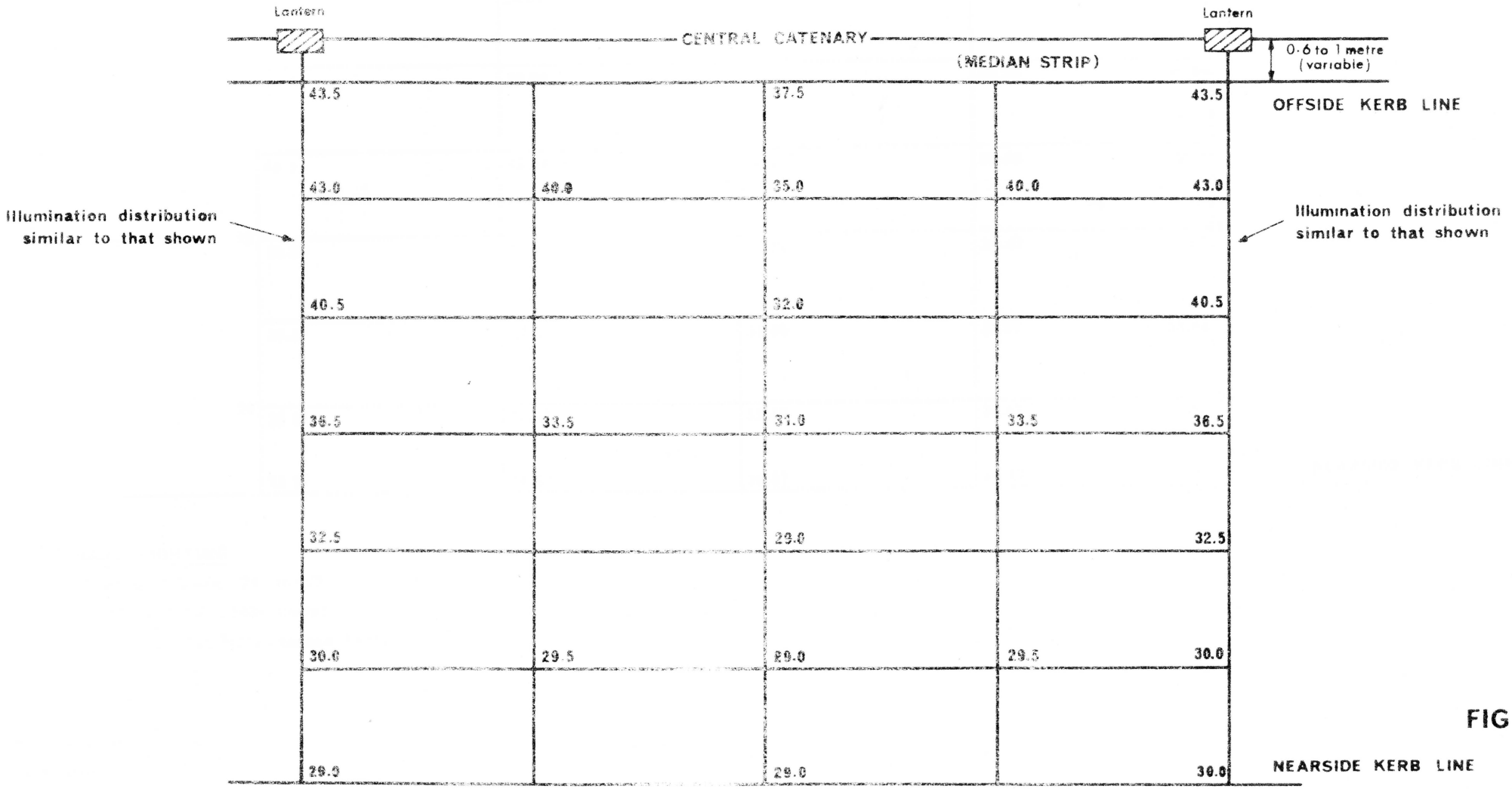
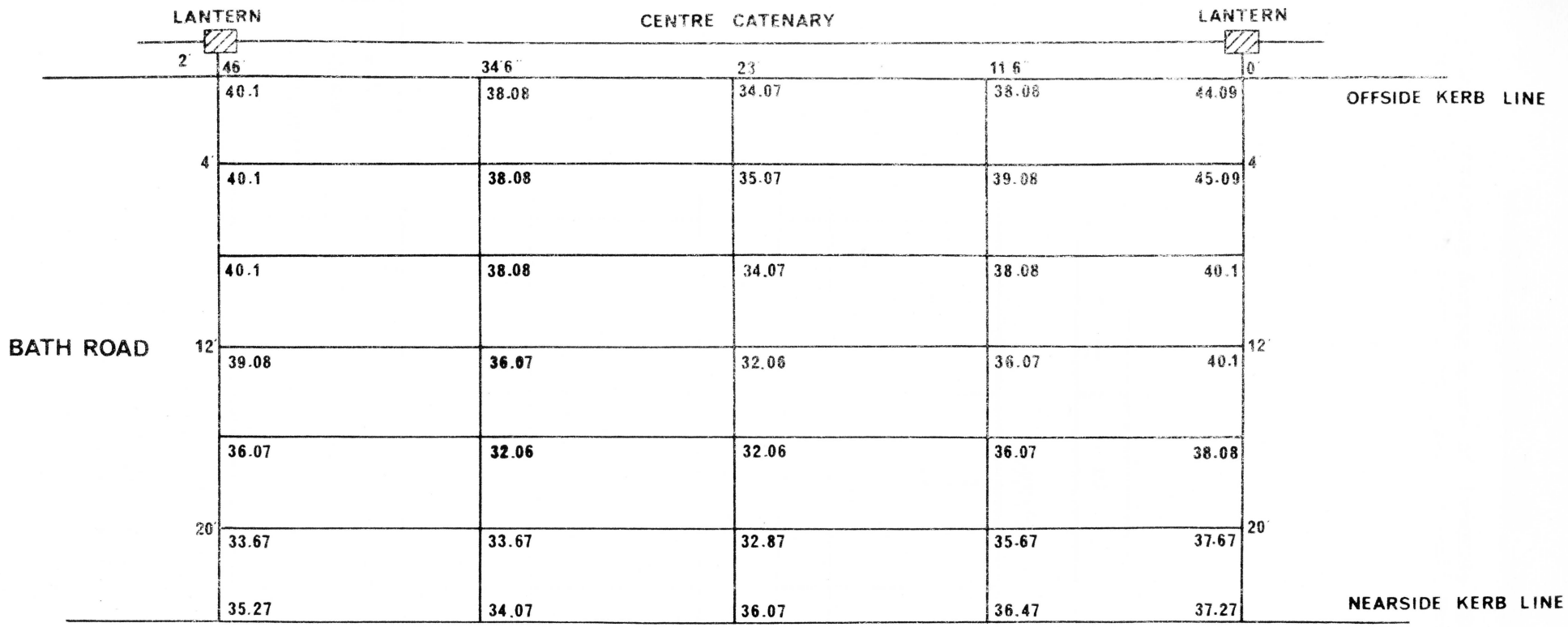


FIG 3

ILLUMINATION (LUX)



A4 CATENARY LIGHTING

Photometric Readings Taken 21–10–71

Light Source :- 135w SOX (2000 Hours)

Lantern :- MO 62 Philips (25% Maintenace Factor)

Conditions :- Dry, Slight Wind

Surface :- Black Top

LUMINANCE READINGS

Min. 0·8 cd/m^2

Ave. 1·3 "

Max. 1·5 "

FIG 4

FIGURE 5

CATENARY LIGHTING SYSTEM (Accident Analysis)

Accidents occurring during hours of darkness along A.4 Great West Road between Parkway, Cranford, and junction with Boston Manor Road (a length of approximately 8 km).

1969/70

MONTH	FATAL	SERIOUS	SLIGHT	TOTAL
October	-	1	7	8
November	1	4	12	17
December	1	1	8	10
January	-	4	4	8
	2	10	31	43

1970/71

October	-	1	2	3
November	-	5	5	10
December	1	2	9	12
January	-	2	3	5
	1	10	19	30

1971/72

October	-	2	-	2
November	-	1	4	5
December	-	3	2	5
January	1	1	5	7
	1	7	11	19

1972/73

October	-	1	3	4
November	-	2	-	2
December	-	1	4	5
January	-	1	4	5
	-	5	11	16

1973/74

October	-	-	5	5
November	-	2	5	7
December	-	-	4	4
January	-	1	2	3
	-	3	16	19